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⑤ Security paper for bank notes and the like.

⑦ Security papers according to the invention comprise opposed surfaces for the provision of printing to identify a document formed from the paper, and positioned at least partially between the two surfaces of the paper as a public security feature a security device of not more than 5mm width, which device comprises a flexible, water-impermeable substrate with a layer of metal on one or both sides of the substrate, there being present on one side of the device a continuous metal path along its length, wherein said device has metal-free portions of between 10% and 50% of the area of the device, said metal-free portions along the length of the device providing a repeating pattern, design, indicia or the like with at least some of the metal-free portions across the transverse direction of the device being wholly surrounded by metal. The metal-free portions may provide characters of a language, such as letters of the English alphabet. The security device may be a strip or thread and this may be positioned in a window, or in an aperture where two windows are impartial or complete register.

**EP 0 319 157 A2**

## SECURITY PAPER FOR BANK NOTES AND THE LIKE

The invention is concerned with security paper for bank notes and the like, and to processes for producing such paper.

It is widely known to use in bank notes security strips or threads which are made from a transparent film provided with continuous reflective metal layer, vacuum deposited aluminium on polyester being the commonest example. Bank notes made from such paper have been in general circulation in many countries for many years. The principal feature of such threads is that when they are embedded in security paper, and the paper is subsequently printed to provide the security document, which includes bank notes, the thread cannot be readily discerned in reflected light but is immediately apparent as the security thread provides a dark image when the document is viewed in transmitted light. Such well-used security threads are simple in concept, but the device is extremely effective since the optically variable effect which is provided cannot be accurately simulated, for example by printing a line on the paper. The continued widespread use of this security feature for many years after its first introduction is a strong indication of its efficacy.

It is known that metallised films can be produced such that no metal is present in controlled and clearly defined areas. Such partly metallised film can be made in a number of ways. One way is to selectively demetallise regions using a resist and etch technique such as is described in US Patent Specification No. 4652015. Other techniques are known for achieving similar effects; for example it is possible to vacuum deposit aluminium through a mask or aluminium can be selectively removed from a composite strip of a plastic support and aluminium using an excimer laser.

It is important to provide even better security paper in order to enhance the public perception/recognition of a security thread for the purpose of authentication by the public. This may be achieved by incorporating within the security thread a pattern which is readily recognisable by the public while retaining the widely accepted optically variable effect which is provided by the continuously metallised strip. Many currencies of the world incorporate a microprinted thread incorporating fine printed characters but these are generally too small to be recognised in a printed document with the unaided eye. If the printed characters are made larger, they are very obvious when viewed in reflected light and readily simulated by a counterfeiter. The present invention makes use of a pattern or characters sufficiently large so as to be readily perceived by the naked eye and formed from a partially metallised strip such that the strong optically variable effect of a continuously metallised strip is essentially retained.

According to the present invention there is provided security paper comprising opposed surfaces for the provision of printing to identify a document formed from the paper, and positioned at least partially between the two surfaces of the paper as a public security feature a security device of not more than 5mm width, which device comprises a flexible, water-impermeable substrate with a layer of metal on one or both sides of the substrate, there being present on one side of the device a continuous metal path along its length, wherein said device has metal-free portions of between 10% and 50% of the area of the device, said metal-free portions along the length of the device providing a repeating pattern, design, indicia or the like with at least some of the metal-free portions across the transverse direction of the device being wholly surrounded by metal. It will be understood that a metal-free area of 10% to 50% requires a metal cover of from 90% to 50%, and the metal cover is preferably on one side of the security device, but may be present on each side with some or no overlap. The security device may be a strip or thread having a width of 0.5 to 5mm, and preferably has a width of 1 to 3mm, eg about 1.6mm.

Preferably the metal-free portion provides characters of a language, such as letters of the English alphabet; alternatively a wide variety of patterns or designs may be employed provided always that the strip or thread has at least one continuous metal path. The continuous metal path may be at one or both edges of the strip or thread, or it may be positioned intermediate the edges or it may vary along the length of strip from the edge to intermediate locations. The strip or thread may have parallel sides or one or both sides may have a regular or irregular non-linear configuration. The strip may be a plastics substrate with a partial covering of metal on one side thereof. Further, though not preferred, the strip or thread may have metal on both sides of a plastics substrate, and the non-metallised areas may overlap to provide an appropriately sized metal-free area.

It is preferred that the metal coverage is from 55% or 60% to 90%, and more preferably from 60% to 85% of the area of a strip or thread. In certain desirable embodiments of this invention a strip or thread is positioned within a watermark or the strip or thread is exposed by means of being placed within a window or an aperture of the paper where no or virtually no paper fibres are present on the strip.

In one embodiment of the invention, there is present on either or both sides of the security device a dye or a fluorescent material, which may be the same or different when the dye or fluorescent material is present on both sides of the strip or thread. It is to be understood that the term "dye" extends to colouring materials generally and includes pigments which can colour transmitted or reflected light. Also, the term "fluorescent material" extends to other materials which, when excited by suitable radiation emit characteristic radiation; for example the term includes phosphorescent materials and other materials which emit characteristic radiation when excited by radiation other than UV light. In a further embodiment of the invention the strip or thread comprises a plastics substrate with the metal on one side thereof, and a dye or fluorescent material is present in the plastics substrate or on the surface of said substrate. Also, the strip or thread may comprise a plastics substrate with the metal on one side thereof, and a dye or fluorescent material present in a coating on the surface of the metal. A dye or fluorescent material does not need to be present uniformly on one side of the security device, although a uniform layer is preferred. Furthermore, the strip or thread may comprise a plastics substrate with the metal on one side thereof and a dichroic layer present on at least one side of the device.

It is an important feature of the present invention that a counterfeiter is not able to simulate the effect of the continuously metallised portion or portions of a thread or strip as used in this invention by a simple drawn or printed line. For printing to be used to simulate a security paper according to the present invention, skillful printing is needed, but no printing can adequately simulate the contrast which is provided when the document produced using this invention is examined in transmitted and reflected lights when a marked contrast is obtained with a genuine document.

The security paper described in US Patent Specification No. 4652015 is an attempt to achieve at least some of the benefits which are provided by the present invention. However, this present invention is far better suited to defeating the aims of counterfeiters and to providing the public with a readily verified security document, since the paper of this invention retains the widely recognised and very strong optically variable effect of a continuous metallised film by virtue of the fact that the major portion of the area of the strip or thread is metallised and there is continuity of metal along the length of the thread. A bank note or the like which is produced according to the aforementioned US Patent Specification would be vulnerable to simulation by a printing technique using, for example, opaque white or cream inks on one surface of the paper; such a simulation may well be imperfect but experience has shown that it could be more than adequate to deceive many of the public. The optically variable effect of the metal characters used in the threads of US Patent Specification No. 4652415 would not be accurately simulated but since the characters occupy only a minority of the thread area, any deficiencies in simulation may be easily overlooked. Furthermore it will be understood that the continuity of metal along the thread in this invention greatly enhances the ability to authenticate a bank note or other security document on a used-note sorting machine.

The invention also includes a process for making security paper as described above wherein a preformed security device is incorporated into paper during a continuous papermaking process to produce paper from which a plurality of substantially identical pieces of paper can be obtained which, when printed, form substantially identical security documents, such as bank notes. The continuous papermaking process may employ a Fourdrinier papermaking machine or a cylinder mould papermaking machine. The process may use a cylinder mould papermaking machine substantially as described in EP 0 059 056 to produce paper having windows in each of which there is present a portion of the security device. In a further process for making security paper the security device is positioned continuously between two webs of paper which are laminated together to produce the security paper.

It will be understood that the use of legends, characters, geometric patterns and the like greatly enhance the security of the thread when used in a windowed or apertured form. Windows may be provided by means known in the art other than those disclosed in our specification EPO 059 056. An alternative technique is to embed the strip or thread between two layers of fibre formed separately on a paper machine and subsequently brought together to form a single sheet whereby at least one of the plies contains a sequence of holes formed by a watermark or other process such that these holes (which contain no, or virtually no fibre) are at least partially located over the strip or thread thus exposing it. If the holes are found in one layer of fibre only, the security strip or thread will be exposed, or windowed, on one surface only of the final sheet. If the holes are present in both fibre layers but in different locations, the strip or thread will be exposed, or windowed, on both sides of the final sheet in different locations. If the holes are present in both fibre layers such that they are at least partially in register with each other and the strip or thread, then the strip or thread will be simultaneously exposed on both sides of the sheet to form an aperture.

One of the most important benefits of using partially metallised threads where some of the thread is exposed is in the prevention of counterfeiting where counterfeiters are produced using a colour photocopier or

scanner. This is more clearly explained in example 8.

Bank notes and other security documents produced from security paper according to this invention incorporate a security thread which is virtually undetectable in reflected light but which, when the paper is viewed by transmitted light without the aid of a lens or other viewing accessory, exhibits as strong highlights the pattern, design or Indicia against the metal background which is much darker than the paper adjacent to the thread; also the highlighted areas which provide the pattern, design, Indicia or the like may be brighter than the paper adjacent to the thread, for example where a relatively wide strip is incorporated into paper during fibre deposition.

When a dye is used in a layer on one side of the security strip or thread or one of these agents is incorporated in a plastics substrate for the metal, then the highlight areas will be coloured when illuminated with transmitted light and the colour can be significantly different from that of the paper adjacent the strip or thread. Similar effects can be achieved when the additional layer comprises a fluorescent material and illumination is effected with transmitted UV or IR light or other stimulating radiation; a further check on authenticity can be achieved in an appropriate security paper according to this invention by viewing in transmitted white light and comparing the image with that obtained by viewing with transmitted stimulating radiation.

It is to be understood that a security document made from security paper in accordance with this invention may be provided with two or more of the security strips described herein, and the security strips may be the same or different.

In one preferred form of the invention the non-metallised areas, that is the pattern, design, Indicia, characters or the like are individually wholly surrounded by metal, the metal being present along the edges of the strip or thread. Furthermore, a strip or thread is constituted by a clear plastics film which is partially metallised on one side only and the continuous metal layer extends inter alia along the two edges of the plastic strip or thread parallel to the longitudinal axis thereof.

It is to be understood that the strip or thread may be of uniform width or may vary in width as is the case with certain known security threads. For threads of uniform width, then preferably the thread width may range from 0.5 mm to 2.0 mm, with character or Indicia heights (i.e. the dimension across the width of the thread) in the range 0.3 mm to 1.5 mm. However, wider strips or threads may be used depending upon the procedure used to incorporate a strip or thread into the security paper. The strips or threads may be formed from transparent colourless plastic film with partial demetallisation providing the pattern, design, Indicia or the like, and this film will then be slit to provide strips or threads of appropriate width, such as 1.2 mm.

Further variable visible effects can be obtained in accordance with this invention when one or both sides of the partially metallised strip or thread is provided, prior to its insertion into paper, with a uniform coating of a dichroic film; the colour perception of the metallised and highlight regions will then change with the viewing angle and/or according to the direction of illumination. The visual effects with a dichroic strip or thread are enhanced when the dichroic material is situated under a window formed in the paper such that the dichroic coating of the strip or thread is exposed.

A bank note or other security document produced from security paper according to this invention contains a strip or thread which provides an electrically conductive path extending along the length or width of the paper; such strip or thread may therefore be detected using conventional metal thread detection equipment on, for example, a used-note sorting machine. This property of the threads or strips according to this invention being detectable with conventional metal thread detection equipment is a valuable property which is not present in the case of bank notes or other security documents produced according to US Patent Specification No. 4652015. Furthermore, by provision of a suitable detector, the distribution of metal within the strip or thread may be determined by electrical, optical or other means and compared to a reference pattern to provide a further technique for the authentication of a genuine document containing the strip or thread.

Additionally, where the metal and/or highlight areas are coloured or provided with a fluorescent coating according to one of the techniques already described, then by provision of a suitable illumination and detection system the coloured metal and/or highlight areas may be compared to a reference pattern as a further technique for authentication of a genuine document containing the strip or thread.

Following is a description by way of example of various security papers in accordance with this invention:

#### Example 1

In one embodiment of the invention, transparent colourless plastic film which is partially metallised as described herein is slit to threads typically 1.2 mm width where the metal content forms 67% of the area of the thread. The thread is inserted into paper e.g. on a cylinder mould paper machine so that the total grammage of paper above and below the thread is significantly less than that of the grammage of paper adjacent to the thread, and in said paper the highlight areas, which are provided by the demetallised portion of the thread, when viewed in transmitted light are brighter than the paper adjacent to the thread.

#### Example 2

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In another embodiment of the invention, transparent colourless plastic film which is partially metallised as described herein is uniformly coated on the metal-free side with a layer containing a dye or a fluorescent material. The film is then slit to form threads and inserted into paper. When the paper is viewed in the appropriate reflected light (visible, UV or IR), the coated side appears uniformly coloured whereas on the uncoated side only the highlight areas appear to be coloured. In transmitted light, the highlight areas only appear to be coloured regardless of which side is facing the observer.

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#### Example 3

In another embodiment of the invention, transparent colourless plastic film is partially metallised as described herein, uniformly coated on one side with a layer containing a dye or fluorescent material and uniformly coated on the other side with another material of a different colour. The film is slit into threads and inserted into paper. In reflected light, each side will exhibit its own particular colour more or less uniformly although there may be some colour mix in the highlight areas. In transmitted light however, the highlight areas will be perceived as a third colour which will be a mix of the other two and markedly distinguishable from them.

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#### Example 4

In another embodiment of the invention, transparent colourless plastic film is partially demetallised as described herein by means of a chemical resist and etch process whereby the resist which is positioned over the metal area where it is desired to retain the metal may be doped with a dye or fluorescent material. The film is then slit to form threads and inserted into paper. When the paper is viewed in the appropriate reflected light on the metallised side, the metal areas only appear coloured; the highlight areas are not coloured. When the paper is viewed on the unmetallised side of the thread, no colour is observed.

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#### Example 5

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In another embodiment of the invention, transparent colourless film is partially demetallised with a resist incorporating a dye or fluorescent material and the unmetallised side uniformly coated with a material containing a dye or fluorescent material of a different colour. The film is then slit to form threads and run into paper. When the paper is viewed in reflected light on the unmetallised side of the thread, a uniform colour is observed. When the paper is viewed in reflected light on the metallised side, the metal regions appear in one colour and the highlight regions in the second colour. When the paper is viewed in transmitted light, only the highlight regions are observed in the colour of the coating on the unmetallised side regardless of which side of the thread is facing the observer.

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#### Example 6

Example 2 was modified by incorporating the dye or fluorescent material into the plastics material before metallisation. Similar visual effects were achieved to those of Example 2 when partially demetallised threads having the dye or fluorescent material in the plastics substrate were incorporated into paper.

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#### Example 7

In another embodiment of the invention, transparent colourless plastic film which is partially demetallised as described herein is provided with a dichroic coating deposited on one or both sides. The colour perception of the metallised and highlight areas then changes according to viewing angle and/or according to the direction of illumination.

This embodiment is enhanced if used with paper with windows or apertures.

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#### Example 8

In another embodiment of the invention, a transparent plastic film as described in any of the examples 1 to 7 is slit to form threads and inserted into paper such that at predetermined intervals along the thread it is exposed at the surface on one side of the paper sheet in accordance with the technique described in EP-B-0 059 056. The presence of the highlight regions of the partially metallised thread in regions of the paper where the thread is exposed or "windowed" at the surface of the paper greatly increases the difficulty of simulating the appearance of these latter regions and enhances the overall security of the document. In transmitted light, the predominantly metal strip is very clearly seen to be continuous but when the front i.e. windowed surface of the paper is viewed in reflected light there is a very sharp contrast between the highly reflective exposed regions of metallised thread and the same metallised regions embedded in a fibre bridge between two windows where the thread is virtually invisible. The full benefits of the incorporation of coloured or fluorescing agents as described in Examples 2 to 6 are most apparent when security threads are used in windowed form, as more fully described in Example 12.

The benefits of using a partially metallised thread in the afore-mentioned arrangement is of great importance with respect to protection against counterfeits. When banknotes or other documents containing a security thread manufactured according to this example are reproduced on a colour photocopier or laser scanner machine, the metallised regions of the security thread in the exposed areas are reproduced as black or dark regions and the highlight regions are reproduced as white or light regions. In order to simulate the appearance of the genuine printed document the counterfeiter must then provide by some means a "metallic" appearance in the appropriate regions leaving the highlight regions clear. This is a complicated and tedious operation and more difficult than simulating the appearance of a wholly metallised security thread. Thus paper produced according to this example has enhanced security against counterfeits produced using colour photocopier or laser scanning machines.

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#### Example 9

In another embodiment of the invention, a transparent plastic film according to any of the examples 1 to 7 is slit to form threads and inserted between two layers of fibre formed independently on a paper machine prior to bringing these two layers together. A watermarking process is used to produce regions in one of the layers where the fibre thickness is locally reduced to a very thin layer or to produce no fibres at all, i.e. a hole. Alternatively a sequence of holes is produced in one of the layers by a water jet or some other means. The thread is arranged to run across these holes or thin areas such that the thread is virtually or completely exposed on one surface of the final paper sheet in predetermined locations.

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#### Example 10

In another embodiment, a process similar to that described in example 9 is used except that a

sequence of holes or regions of thin fibre coverage is produced in two layers of paper prior to bringing them together such that the thread is exposed in a predetermined manner on both sides of the final paper sheet.

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#### Example 11

In another embodiment, a process similar to that described in example 10 is used except that the holes or regions of thin fibre coverage in two layers are brought together at least in partial register with each other and the thread such that the thread is exposed simultaneously on both sides of the sheet in predetermined locations, that is the thread runs through one or more apertures.

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#### Example 12

In another embodiment of the invention, transparent colourless film is partially demetallised with a resist incorporating a dye or fluorescent material and the unmetallised side uniformly coated with a material containing a dye or fluorescent material of a different colour. The film is then slit to form threads and run into paper in accordance with the technique described in EP-B-0059056 such that regions of the thread are exposed on one surface of the sheet.

Where the metallised side of the thread is exposed in the windows of the paper there is a very strong contrast between the metallised region, coloured due to the colouring agent in the resist, and the highlight regions, coloured due to the colouring agent in the uniform coating, when the paper is viewed in the appropriate reflected light on that side of the sheet; the contrast is more dramatic than for those regions between the windows where the thread is covered by fibre on both sides. In transmitted light only the highlight regions are observed, which are coloured due to the colouring agent in the uniform coating, and are seen to be brighter in those window regions where the thread is exposed on one side than between the windows where the thread is covered with fibre on both sides.

Where the non-metallised side of the thread is exposed in the windows of the paper and the paper is viewed on that side in the appropriate reflected light, the thread has a nearly uniform colour which is brighter in the window regions than between windows where the thread is covered with fibre. In transmitted light, again only the highlight regions are coloured due to the colouring agent in the uniform coating and are seen to be brighter in the window regions than between windows.

As an alternative to the use of a uniform coating on the non-metallised side of the thread, a dye or fluorescing agent may be incorporated into the plastic film to achieve the same effects.

These pronounced effects draw attention to the presence of the highlight regions in the partially metallised strip and greatly enhance the difficulty of simulating a metallised security thread in window threaded paper.

The accompanying drawings illustrate security threads which can be used in accordance with this invention. The security threads are presented in an enlarged form and in use their width typically is 1.2 mm. The threads are all formed by demetallising vacuum deposited aluminium which is supported on a polyester film. The aluminium was removed by using a resist and etch technique.

The metal contents of the threads shown in the drawings are set out in the following table.

TABLE

Figure 1	84%
Figure 2	67%
Figure 3	55%
Figure 4	63%
Figure 5	84%
Figure 6	79%
Figure 7	89%
Figure 8	61%





2. Paper as claimed in claim 1 wherein the security device is a strip or thread having a width of 1 to 3mm.

3. Paper as claimed in claim 1 or claim 2, wherein the metal free portion provides characters of a language, such as letters of the English alphabet.

5 4. Paper as claimed in any one of the preceding claims, wherein the area of the metal-free portions is from 10% to 45% of the area of a strip or thread.

5. Paper as claimed in any one of claims 1 to 4, wherein portions of a strip or thread are positioned in windows where there is no or virtually no paper fibres on the strip or thread, or a portion of the strip or thread is positioned in an aperture with two such windows in partial or complete register.

10 6. Paper as claimed in any one of the preceding claims, wherein there is present on either or both sides of a security device a dye or a fluorescent material, which may be the same or different when the dye or fluorescent material is present on both sides of the strip or thread.

7. Paper as claimed in claim 6, wherein the strip or thread comprises a plastics substrate with the metal on one side thereof, and a dye or fluorescent material present in the plastics substrate or on the surface of  
15 said substrate, or in a coating on the surface of the metal.

8. A paper as claimed in any one of claims 1 to 5 wherein the security device comprises a plastics substrate with the metal on one side thereof and a dichroic layer present on at least one side of the device.

9. A paper as claimed in any one of the preceding claims wherein the paper is made from synthetic fibres, or from synthetic and natural fibres, or is made by laminating at least two sheets of synthetic  
20 material, the security device being positioned between the two sheets.

10. A process for making a security paper as claimed in claim 1, wherein a preformed security device is incorporated into paper during a continuous papermaking process to produce paper from which a plurality of substantially identical pieces of paper can be obtained which, when printed, form substantially identical security documents, such as bank notes.

25 11. A process as claimed in claim 10, wherein there is used a cylinder mould papermaking machine substantially as described in EP 0 059 056 to produce paper having windows in each of which there is present a portion of the security device.

12. A process as claimed in claim 10 wherein the security device is positioned continuously between two webs of paper which are laminated together to produce the security paper.

30 13. A bank note or other security document when produced from paper as claimed in any one of claims 1 to 9.

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*FIG. 1.* **PORTALS b0b**

*FIG. 2.* **PORTALS b**

*FIG. 3.* **PORTALS b**

*FIG. 4.* **PORTALS PORTALS PORTALS PORTALS**

*FIG. 5.* **△:△:△:△:△:△:△:△**

*FIG. 6.* **~~~~~**

*FIG. 7.* **/// /// /// /// ///**

*FIG. 8.* **~~~~~**